



National Aeronautics
and Space Administration

Educational Product

Teachers

Grades K-12

EG-2000-10-64-MSFC

OPTICS

Light, Color, and Their Uses

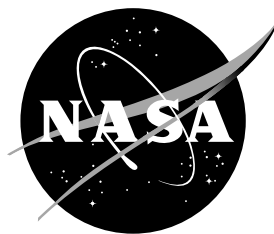
An Educator's Guide With Activities
In Science and Mathematics



Optics:

Light, Color, and Their Uses

An Educator's Guide With Activities in Science and Mathematics



National Aeronautics and Space Administration

**Space Optics Manufacturing Technology Center
Marshall Space Flight Center**

**Customer Employee Relations Directorate /
Education Programs Department
Marshall Space Flight Center**

This publication is in the Public Domain and is not protected by copyright.
Permission is not required for duplication.

EG-2000-10-64-MSFC



Optics: Light, Color, and Their Uses

An Educator's Guide

With Activities in Science and Mathematics

Acknowledgments

Pat Armstrong
Curriculum Development Coordinator
Huntsville City Schools
Huntsville, AL

P. Derryl Evans
Optical Physicist
Retired from NASA Marshall Space
Flight Center
Huntsville, AL

Vinson B. Huegele
Optical Physicist
Space Optics Manufacturing
Technology Center
NASA Marshall Space Flight Center

Era Jean Mann
Computer Specialist
Retired from NASA Marshall Space
Flight Center
Huntsville, AL

Vicki Smith
IPA/Huntsville City Schools
Education Program Specialist
NASA Marshall Space Flight Center
Huntsville, AL

On the Cover

Replicated X-ray Mirror

The reflective tube is an x-ray telescope mirror made as a shell cast from a mold called a mandrel. The cylindrical mandrel is carefully shaped and polished until it has the proper optical surface. Then gold, followed by nickel, is electroplated onto the mandrel. The electroplated metal then comes off the mandrel and the shell formed is a high-precision mirror on the inside. The mandrel can be used again to replicate many mirrors with the same shape.

The x-ray mirrors in the Chandra Observatory are made of glass. Metal mirrors replicated from a mandrel are much lighter and cheaper than glass, so they are desirable for space applications. The Marshall Space Flight Center (MSFC) is advancing replicated optics technology.

Shown in the picture are students Colton Guthrie and Laquita Hurt, with MSFC optical physicist Vince Huegele.



Classroom Activities

This material has been developed to provide a guide to hands-on experiences in science and mathematics. The activity plans are written to be used by the students in groups of two to four people in a lab-type setting.

Each lab session should begin with a brief discussion of the theory section of each lesson plan. The teacher should feel free to adjust the information and activities to meet the needs of the students. For the very young student, the teacher may want to lead the experience activity and adapt the questions.

Pat Armstrong

Activities for Grades K–4

- Activity 1: Reflection of Light With a Plane (Flat) Mirror
- Activity 2: Reflection of Light With Two Plane Mirrors
- Activity 7: Exploring Diffraction With a Spectroscope
- Activity 10: Light and Color-Color Spinners
- Activity 11: Light and Color-Filters
- Activity 12: Light and Color-Hidden Messages
- Activity 13: Simple Magnifiers

Activities for Grades 5–8

- Activity 1: Reflection of Light With a Plane (Flat) Mirror
- Activity 2: Reflection of Light With Two Plane Mirrors
- Activity 3: Reflection of Light With Two Plane Mirrors-Double Sided
- Activity 5: Making a Periscope
- Activity 6: Constructing a Spectroscope
- Activity 7: Exploring Diffraction with a Spectroscope
- Activity 10: Light and Color-Color Spinners
- Activity 12: Light and Color-Hidden Messages
- Activity 13: Simple Magnifiers

Activities for Grades 9–12

- Activity 4: Making a Kaleidoscope
- Activity 5: Making a Periscope
- Activity 8: Diffraction of Light by Very Small Apertures
- Activity 9: Discovering Color With a Prism
- Activity 14: Focusing Light With a Lens
- Activity 15: Building a Telescope
- Activity 16: Building a Microscope
- Activity 17: Interference Fringes
- Activity 18: Polarization of Light



Table of Contents

Light, Color, and Their Uses

Activity / Lesson

	National Science Standards	1
	National Mathematics Standards	2
	Introduction to Light and Color	3
	Introduction to Mirrors and Lenses	5
1	Reflection of Light With a Plane (Flat) Mirror—Trace a Star	13
2	Reflection of Light With Two Plane Mirrors—Double Mirrors Placed at a 90-Degree Angle	17
3	Reflection of Light With Two Plane Mirrors—Double Mirrors Placed at a Number of Angles	19
4	Making a Kaleidoscope	23
	Construction of a Large Kaleidoscope Using PVC Pipe	25
5	Making a Periscope	27
6	Constructing a Spectroscope	29
7	Exploring Diffraction With a Spectroscope	31
	The Electromagnetic Spectrum	34
8	Diffraction of Light by Very Small Apertures	35
9	Discovering Color With a Prism	37
	Fabrication of a Prism From Acrylic Plastic	40
10	Light and Color—Color Spinners	41
11	Light and Color—Filters	43
12	Light and Color—Hidden Messages	45
13	Simple Magnifiers	47
14	Focusing Light With a Lens	49
15	Building a Telescope	53
	Diagrams of Reflector and Refractor Telescopes	56
16	Building a Microscope	57
	Construction of a Microscope—A File Folder Microscope	59
17	Interference Fringes	61
18	Polarization of Light	63



Teachers' Resource Materials	65
Answer Booklet	65
Glossary	73
General Information for Educators and Students.....	77
NASA Online Educational Resources	79
Education Home Page	79
NASA Spacelink	79
Educator Resource Center and CORE.....	80
NASA Television (NTV)	81
List Of Catalogs	82
Educator Reply Card.....	83





Light, Color, and Their Uses

National Science Standards

Activity/Lesson	Science as Inquiry	Physical Science
1. Reflection/Plane Mirror	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2. Reflection/2 Mirrors	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3. Reflection/Double Mirrors	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4. Making a Kaleidoscope	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5. Construction of a Kaleidoscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6. Making a Periscope	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7. Constructing a Spectroscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8. Exploring Diffraction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9. Electromagnetic Spectrum	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10. Diffraction of Light	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11. Discovering Color/Prism	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12. Fabrication of a Prism	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
13. Color Spinners	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
14. Filters	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
15. Hidden Messages	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
16. Simple Magnifiers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
17. Focusing Light With a Lens	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
18. Building a Telescope	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
19. Building a Microscope	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
20. Construction of a Microscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>
21. Interference Fringes	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
22. Polarization of Light	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>



National Mathematics Standards

Activity/Lesson	Problem Solving	Communication	Connection	Computation/Estimation	Measurement
1. Reflection/Plane Mirror	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2. Reflection/2 Mirrors	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3. Reflection/Double Mirrors	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4. Making a Kaleidoscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Construction of a Kaleidoscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6. Making a Periscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
7. Constructing a Spectroscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8. Exploring Diffraction	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Electromagnetic Spectrum	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Diffraction of Light	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Discovering Color/Prism	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Fabrication of a Prism	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
13. Color Spinners	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
14. Filters	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
15. Hidden Messages	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
16. Simple Magnifiers	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Focusing Light With a Lens	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Building a Telescope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Building a Microscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Construction of a Microscope	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
21. Interference Fringes	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Polarization of Light	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>